Small Ruminant Research 163 (2018) 34–38

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

The advantages of goats for future adaptation to Climate Change: A conceptual overview

Nazan Koluman Darcan[a,*], Nissim Silanikove[b]

[a] Cukurova University, Agricultural Faculty, Dept. of Animal Science, 01330, Adana, Turkey
[b] Institute of Animal Science, Agricultural research Organization (A.R.O.), The Volcani Center, P.O. Box. 6, Bet Dagan 50250, Israel

ARTICLE INFO

Keywords:
Climate change
Goat
Advantages
Adaptation

ABSTRACT

The economic importance of goat production has been increased during the last decades all over the world, predominantly in countries that are routinely exposed to harsh environment. Goats have numerous advantages that enable them to maintain their production under extreme climate conditions. Principally, goats have higher capacity than other farm raised ruminants to effectively convert some feed sources into milk and meat. In addition, goats emit less methane than other domestic ruminants. Based on these advantages, we came to the conclusion that goat breeding will play an important role in mitigating and adapting to Climate change (CC) in harsh environments. The impacts of CC on goat production can be analyzed by considering direct or indirect effects of CC. The direct effects take into account goat's physiology and their interaction with ambient conditions, as well as issues such as the optimal use of natural resource and waste management. Indirect effects consider limitations on goat production from political, social and economic considerations, which are mainly intended for decreasing the greenhouse gas emission effect. In this paper the advantages of goats for future adaptation to CC will be considered.

1. Introduction

Goat production systems and considerations on strategies of adaptation to climate change (CC), which are in mutual interaction with each other, has become recently a popular subject on the public agenda and scientific literature (Silanikove and Koluman, 2015). The total amount of greenhouse gas emission is closely related to the number of livestock. In this regard, the use of small number of goats with better efficiency to convert feed resources into products may become an important strategy to alleviate greenhouse gas emission by livestock (Steinfeld et al., 2006).

Certain applications, particularly those intended for improving the environment and genotype will become important. An ability to lessen the impact of climatic conditions would be closely associated with goat's milk and meat production capacity and the economic trait of production (Darcan and Güney, 2002; Darcan and Cankaya, 2008). Thus, two factors, genetic capacity and mitigation of heat stress, will dictate to large extent the level of productivity per goat and the number of goats in harsh environment. Therefore, actions to decrease environmental stress should be put into practice by taking current changes in CC into account. Recent studies have indeed demonstrated that applying methodologies to mitigate climatic stress, such as ventilation and sprinkling improved productivity of goats (Güney et al., 2006; Koluman et al., 2011). Additional approach which demonstrated positive effects is an improvement in the genetic structure of flock population, in order to optimize goats adaptation to certain conditions along with increasing their productivity level under those conditions (Darcan, 2000; Darcan and Güney, 2002; Silanikove and Koluman, 2015). Thus, we see a great scope for goats farming in the future in harsh environments on the basis of: i. their ability to perform better under harsh environment, ii. to benefit from feed resource, which aren't used by other ruminants iii. To benefit from their superior thermoregulation capacity and ability to cope with water shortage and iv. to benefit from their capacity to emit less methane.

2. Comparison between domestic livestock: the advantages of goats

The advantages of goats for future adaptation of livestock to CC include their ability to actualize 'green agriculture production system' free of large environmental pollution, which typically links with the intensive dairy cows production systems. In this respect, the contributions of goats to protecting the natural life habitual and organic production of food become important considerations (Coban et al.,

* Corresponding author.
E-mail address: nazankoluman@gmail.com (N. Koluman Darcan).

http://dx.doi.org/10.1016/j.smallrumres.2017.04.013
Received 15 February 2017; Received in revised form 17 April 2017; Accepted 18 April 2017
Available online 23 April 2017
0921-4488/ © 2017 Elsevier B.V. All rights reserved.

2008). 'Green agriculture production system' contribute to mitigating the negative effects of abiotic pollutions on human health, which derives to large extend from the uncontrolled use of substances such as antibiotics, which cause the emergence of new diseases, or complications such as resistant bacteria (Coban et al., 2008).

The impacts of CC on goat production analyses as the direct or indirect effects of climatic factors (Silanikove and Koluman, 2015). The goat's interactions with environment in relation to their physiological stage, as well as issues of the uses of natural resource, waste management and crop production become prominent. Reviews on this subject that goat are superior to other ruminants in those respects (Silanikove, 2000; Silanikove and Koluman, 2015). However, a common mistaken belief which repressed goat production is political, social and economic sanctions forced in order to decrease the greenhouse gas emission (Steinfeld et al., 2006). The total greenhouse gas emission is closely related to the number of goats. Thus, the use of high productive breeds of goats can become an important strategy to reduce greenhouse gas from goats. To achieve this goal, improving the adaptation of goat genotype to their environment will become imperative. The economical input on lessening the impact of climate conditions is closely related to a goat's biological capacity. Accordingly, these two factors have an impact on economical considerations. In regard with livestock production, efforts should be made to improve the genetic capacity with regard to the type of goat and increasing the production level per goat. The biological environmental conditions should be taken into consideration in terms of pollution to be caused by preferring conventional methods in the use of natural resources in order to increase production in the unit area. In this respect, issues of protecting the natural life and organic production will become significant. Furthermore, the negative effects on livestock farming, which derives from uncontrolled use of substances, cause the emergence of new diseases that inflict humans. In conclusion, the considerations to use goat or any other farm animal in a given environment should take into account pollution caused by greenhouse, as well as inability to control the waste management in an effective way. Thus, certain negative environmental outcomes that are associated with livestock production are unavoidable; however, choosing to raise goats could minimize those outcomes.

Human food is indispensable input for survival. Hence, food production and nature-agriculture relationship have been always on the agenda. The intensive use of conventional inputs and the competition between food for humans and feed for livestock have raised objections on intensive use of ruminants as source of food for humans, in addition to consideration on their significant input to greenhouse gas emission (Silanikove and Koluman, 2015). In specific regards to goats: problems such as inability to come up with an alternative to stubble burning and similar activities. Lack of an appropriate diet and use of high-quality feed in goat breeding and the pollution which emerges during the production and goat transfer processes should be taken into consideration in the process of CC (Koluman et al., 2011). At this point, conventional or traditional production systems will become another issue to be discussed.

A better understanding of the advantageous and disadvantageous of native resources of goat breeds within a regional projection are highly significant with regard to the success of adaptation programs to be implemented in the long run. Applying genetic and biotechnological approaches are also means to improve adaptation to CC. However, in the present review we would like to emphasize on the local gene resources', which offer resistance and endurance to local extreme environmental conditions. Methane emission in which the live weight and productivity level of local goats considered should also be put forth in such approach. A pilot study, which was performed on this subject, is described below. The calculations that we have made on the methane emission from livestock in Turkey took methane released from the gastrointestinal tract, or through manures by cattle, sheep and goats per goat in different ages and physiological conditions according to IPCC (2007) into account as indicated in the table below (Table 1; based on Görgülü et al., 2009).

Table 1
The annual methane emission of the cattle, sheep and goats in Turkey with origins of enteric and manure.

Species	Enteric, ton	Manure, ton	Total, ton	Enteric,%	Species, %
Cattle	675,394	108,457	783,850	86.16	76.53
Sheep	203,800	6,114	209,914	97.09	20.49
Goat	29,600	888	30,488	97.09	2.98
Total	**908,794**	**115,459**	**1,024,252**		

The majority of greenhouse gas produced by livestock originates mainly from the digestion process in the rumen, while the minority part comes from manure and feed production (Table 1). It is estimated that the methane emission by ruminants in Turkey is approximately 1 million ton and > than 85% of that is of enteric origins (Table 1). Furthermore, it was concluded that 76% of total emission is caused by the cattle population. This estimation represents an increase in methane emission in comparison to that made earlier by the State Institute of Statistics' (DSI) Branch Office of Environmental Statistics at 2000. According to this source, the methane release caused by enteric fermentation totaled 692,000 tons and that the emission caused by fertilizes totaled 37.6 tons (TUIK, 2009).

It's known that the methane emission is related to goats' dry matter consumption. Thus, higher amount of methane gas is released from a unit goat, is an outcome of in goat population and shift toward intensive system. The native breeds with less live weight and less productivity also have less methane emission, which will become an advantage in the future with regard to the use of these goats for production purposes.

3. On the contribution of livestock to the greenhouse effect

Greenhouse gasses (CH_4, CO_2 and nitrous oxide) have capacity to raise earth's temperature and are indirectly responsible for climate change and global warming. After CO_2, the CH_4 is second important gasses which contribute to global warming. Different species take role in this problem and their effect can be determined by different methods. Approximately 700 g/kg of methane production origin from an anthropogenic sources and agriculture accounts for about 2/3 with enteric fermentation being responsible for 1/3 of methane from agriculture (Moss et al., 2000). According to the Jhonson and Jhonson (1995), 80 million Mt of CH_4 is produced by livestock enteric fermentation annually of which is 730/kg is attributable to cattle. In comparison, goat husbandry is responsible for approximately 2.5–4% of total greenhouses effect (Crutzen et al., 1986) and sheep and goats account for about 200 g/kg of emission from enteric fermentation. CH_4 is not only important greenhouses effect but also indicates loss of energy intake (Jhonson and Jhonson, 1995).

To calculate methane emission rate from sheep and goats, different regression equation can be used such as that of Blaxter and Clapperton (1965) and different parameters can be taken into consideration in these equations depend on species and conditions. Blaxter and Clapperton (1965) equation is shown below.

$$E_{CH4} = 1.3 + 0.112D + L(2.37 - 0.05D)$$

E_{CH4} is CH_4 energy of gross intake (%), D is digestibility of gross energy intake (%), L is level of feeding.

Some researchers have been reported that condensed tannins, acacia, calliandra calotthyrsus and lespedeza cuneata etc. when supplemented to the goat diet reduced CH_4 emission with different rates (Carulla et al., 2005; Puchala et al., 2005). Thus the ability of goats to exploit efficiently natural resources (mainly brows) and supplementation rich in tanniferous compounds (Silanikove, 2000) is advantageous characteristic of goats over other ruminant species in methane emis-

sion.

Developing feeding strategies try to minimize CH_4 emission for long-term mitigation of emission of greenhouse gasses into the atmosphere and for short-term economic benefits.

According to Macfarlane and Howard (1972), water turnover is proportional to feed intake. McDowell and Woodward (1982) have noted that goats have certain traits which were advantageous in situations where water resources were limiting. These were higher heat tolerance to dehydration, less susceptibility to respiratory rates and fewer metabolic disorders than cattle and sheep. Goats have a lower water turnover rate compared to camel, followed by sheep and cattle (Macfarlane, 1968), and since as a rule they prefer semi-arid and sub-tropical climates where ambient temperatures are high and rainfall relatively low, there have been several adaptations to cope with scarcity of especially water and also feed (Devendra, 1987). In draught conditions the goats have identified four adaptations as (Robertshaw, 1982);

- ability to desiccate the feces,
- ability to concentrate the urine and thereby reduce urine volume,
- ability to reduce evaporative water loss,
- utilization of the rumen as a water reservoir.

Those characteristic were identified as important traits in the adaptation of goats to harsh environments (Silanikove, 2000).

4. Indirect effects of CC on goat production

The CC is expected to create indirect impacts on quality and amount of goat feeds, feeding strategies, seasonal usability of grasslands, genetic studies (hybridization, etc.) and the number of goats (Silanikove and Koluman, 2015). The quality and quantity of goat feed is important with regard to the rations prepared. The grain (wheat, barley, etc.) which is used as goat feed and oily seed residues (cotton-seed residues, sunflower seed residues, etc.) ensure that the rations are prepared with the lowest cost without losing any nutritional value (Koluman Darcan et al., 2009).

The CC impact goat production in some ways; these are physical environment, biologic environment, climate and chemical environment as given in Fig. 1.

The impacts of global warming on farm goats emerge as the physical environment, biological environment, chemical environment or direct climate impact. Effects of climate change on grassland grasses were summarised in Fig. 2. The physical environmental conditions appear with possible changes in the feeding conditions. The sheltering becomes more costly due to extreme climate conditions (too warm or too cold) and certain qualities aimed at performance such as milk and meat productivity are likely to lag behind. Studies conducted under extreme climate conditions have demonstrated an impact on goats in terms of the milk quality and quantity and cause a decrease in the lactation period in dairy goats (Chase and Sniffen, 1988; Bucklin et al., 1991; Alnaimy et al., 1992). Studies on the reproduction performance found that the fertility decreases (Alnamier et al., 2002; De Rensis et al., 2002). The estrous couldn't clearly determine and thus the interval to first insemination (days) increases and the pregnancy rate decreases (Alnamier et al., 2002; De Rensis et al., 2002). Blood flow to the uterus decreases under high ambient temperature and together with the increase in body temperature occurs a rise in the uterus temperature. Consequently, decrease in fertilization rate limits the embryonic development and aggravate early embryonic fatalities (De Rensis et al., 2002). In young goats' growth and development are negatively affected by these conditions (Koluman Darcan et al., 2009; Coban et al., 2008; Darcan, 2005). Furthermore, it was reported that high environmental temperature reduce voluntary feed intake, feed efficiency and extend the fattening period (Davis et al., 2001; Silanikove, 2000).

The grassland or crop production and its quality could be slump down due to decrease in water resources and the land availability for crop production. There could be tendencies towards producing food which can be aimed at firstly feeding human on available lands, as the lands appropriate for crop production could shrink due to the increasing sea-water level, drought or salinity, etc. (Silanikove and Koluman, 2015). The competitive power of the goat feed production will decrease due to economic reasons and priorities of general agricultural and industrial activities. Accordingly, a decrease in the competitive power will emerge as the first situation to be caused by the emergency of feeding problems in goats. As the precipitation regime changes, some agricultural lands will suffer drought, whereas some others will experience salinity. Thus there will be competition between the feed

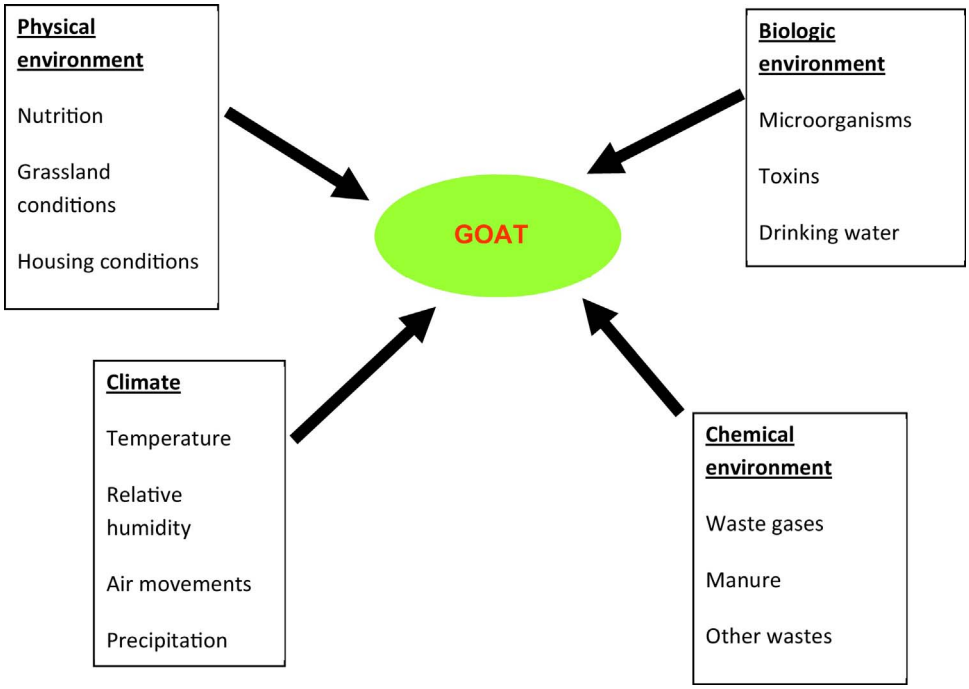

Fig. 1. Classification of expected effects of climate change on goat production (Koluman Darcan et al., 2009).

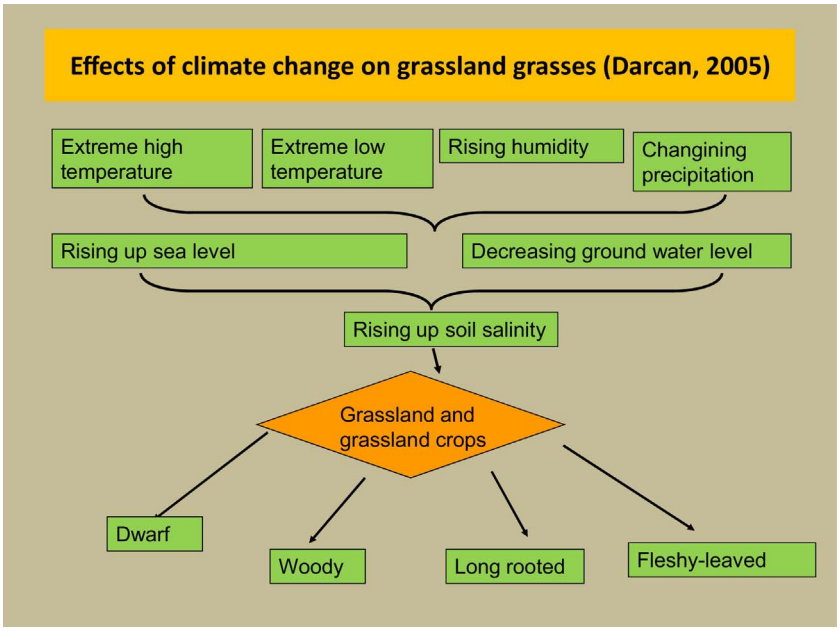

Fig. 2. Effects of climate change on grassland grasses (Darcan, 2005).

crop and alternative plants on lands consisting of agricultural production and the cost will be a prominent issue at this point. Furthermore, short, woody and leafy plant species with long roots appropriate for water storage which are resistant to salinity and draught will become prominent in vegetation. These plant species are among special ones which could be greatly utilized by goats in an effective way (Koluman Darcan et al., 2009; Silanikove, 2000; Silanikove and Koluman, 2015).

5. The potential for genetic improvement

The studies on genetic improvement of farm goats in terms of production qualities and productivity have always been under discussion. But local goats' capacity of maintaining their productivity in all circumstances and their advantageous situation with regard to negative environmental impacts should be taken into consideration. Therefore the work on genotype should be based on selection. The qualities of local gene resources such as length of life, goat health and productivity have an impact on the greenhouse gas emission, and thus they will be able to maintain their advantages over hybrid stocks even under climate changes. Furthermore, they are less affected by short heat waves due to their anatomic and advanced thermoregulation capacity enabling them to easily excrete the extra heat (Silanikove and Koluman, 2015). Besides the productivity level, the length of life could also be affected by climate changes. An increase in such incidents as drought, flood and epidemic diseases is expected due to the climate change (Silanikove and Koluman, 2015). Therefore it's important to start genetic selections with goats which are resistant particularly to drought and diseases. Important traits in such selection schemes are skin and hair type, sweat gland capacity, reproduction rate, ability to maintain productivity in difficult conditions, resistance to local diseases and parasitic infestation, metabolic heat production, tolerance to draught, anatomic and morphologic structure are some important impacts which are likely to derive from climate changes (Koluman Darcan et al., 2009).

A serious threat in stockbreeding will be reflected by certain goat diseases that would increase treatment expenses, productivity losses and immunity, such as blue tongue, and gastroenteritis. Many factors such as easier spread of disease vectors and an increase in atmosphere temperature, due to shorter cold seasons with temperatures above 15° C will play a role in the emergency of these diseases. Indigenous goats possess high resistance to diseases and external parasites. Thus, indigenous are also likely to be more resistant to disease vectors which will change under the drought and extreme climate conditions in the future. The native goats are able to use the plants rich in lignin effectively by consuming less feed and water (Silanikove, 2000). The ability of goats to resist disease and exploit more efficiency natural resources should be considered as part of the healthy society perspective (Koluman Darcan et al., 2009). These aspects endue local gene resources to be more advantageous than exotic breeds particularly in terms of resistance to diseases, ability to utilize bad vegetation and endurance to drought.

Food-goat feed- fuel supply interactions are another factor that may have negative impacts on the goat feed sector in near future because it will become less profitable. The possibility to use plant residues in biodiesel production in order to meet energy needs will cause these by-products to be used less in goat production in the future. The low atmosphere temperature is one of the most important factors creating negative impacts on the dry matter content of grassland feed crops particularly in springs. The water holding capacity of soil will fall with decreasing precipitation, which will lead to a decrease in the dry matter content in plants. Besides, the biomass of by-products which are used in goat production will be greatly influenced by the climate change and the nutritional value of rations to be prepared will decrease. Therefore the silage and fodder production will lag behind (Koluman Darcan et al., 2009).

The genetic diversity in farm goats is important with regard to food safety and rural development. The applications which are carried out towards these ends will provide stockbreeders with the advantage of goat selection and new genotype development with regard to climate change, varying market opportunities and turning towards new fields which are needed by people. FAO (2007), reported that a great number of goat stocks in the world were under the threat of perishing. The majority of these goats are raised at small enterprises which are run with low inputs, where the plant and goat production based on grasslands is performed simultaneously.

Climate impacts differ, depending up on such factors as goat's age, sex, productivity level and products. The goats adaptation to climate conditions also on the age of goats; younger goats may even perish under conditions in which grown animal endure. For example, rainy and mild climates decrease the mortality rate in young goats whereas extremely high heat and cold conditions decrease their survival. Therefore the sheltering conditions gain considerable attention in goat

production (Koluman Darcan et al., 2009).

6. Conclusions

In this review we highlighted important factors that need to be taken into consideration in selection programs. It can culminate that the length of productive life, which depend on the ability to resist CC and epidemic diseases describe very closely the require qualities for selection to harsh environment. The review emphasize the importance of benefiting from the genetic potential of local goats, which are the most resistant breeds to drought and diseases under given condition. These physiological factors relates to goats ability to maintain productivity in difficult conditions: Low metabolic heat production, tolerance to water deprivation, anatomic and morphologic structure which enable efficient utilization of low quality feeds, skin and hair type, sweat gland capacity, reproductive capacity and, resistance to diseases and parasites, are identified as advantages of goats to future adaptation to CC.

References

Alnaimy, A.M., Habeeb, I., Fayaz, I., Marai, M., Kamal, T.H., 1992. Heat stress. In: Philips, Clive, Piggins, David (Eds.), Farm Animals and the Environment. CAB International, Cambridge, England, pp. 1992.

Alnamier, M., De Rosa, G., Grasso, F., Napolitana, F., Bordi, A., 2002. Effect of climate on the response of three oestrus synchronisation techniques in lactating dairy cows. Anim. Reprod. Sci. 71, 157–168.

Blaxter, K.L., Clapperton, J.L., 1965. Prediction of the Amount of methane produced by ruminants. Br. J. Nutr. 19, 511–522.

Bucklin, R.A., Turner, L.W., Beede, D.K., Bray, D.R., Hemken, R.W., 1991. Methods to relieve heat stress for dairy cows in hot, humid climates. Dairy Sci. Abstr. 1991 (53), 9.

Carulla, J.E., Kreuzer, M., Machmuller, A., Hess, H.D., 2005. Supplementation of *Acacia mearnsii tannins* decreases methanogenesis and urinary nitrogen in forage-fed sheep. Aust. J. Agric.Res. 56, 961–970.

Chase, L.E., Sniffen, C.J., 1988. Feeding and managing dairy cows during hot weather. Feed. Nutr. http://www.inform. umd.edu/Edres/Topic/Agric. Eng.

Coban, Y., Darcan, N., Aslan, N., Karakök, S.G., 2008. Global warming in Turkish Goat production and determining possible effects of climate change. 4. In: National Zootechic Student Conferance. May-2008, Samsun-Turkey.

Crutzen, P.J., Aselmann, I., Seiler, W., 1986. Methane production by domestic animals, wild ruminants, other herbivorous fauna, and humans. Tellus 38B, 271–284.

Darcan, N., Cankaya, S., 2008. The effects of ventilation and showering on fattening performances and carcass traits of crossbred kids. Small Rumin. Res. 75, 192–198.

Darcan, N., Güney, O., 2002. Effect of spraying on growth and feed efficiency of kids under subtropical climate. Small Rumin. Res. 43, 189–190.

Darcan (Koluman), N., 2000. Adaptation Mechanisms and Thermal Stress of Synthetic Goat Types at Cukurova Subtropical Climate Conditions. Cukurova University, Adana-Turkey (PhD Thesis 97 p.).

Darcan, N., 2005. Global warming effects on animal husbandry and alleviation to heat stress. Hasad Hayvancılık Dergisi Yıl: 21. Sayı 243, 27–29.

Davis, S., Mader, T., Cerkoney, W., 2001. Managing heat stress in feedlot cattle using sprinklers. Beef Cattle Rep. www. Liru.asft.ttu.edu/pdf/mp76pg77-81. pdf.

De Rensis, F., Marconi, P., Capelli, T., Gatti, F., Facciolongo, F., Franzini, S., et al., 2002. 2002: Fertility in postpartum dairy cows in winter or summer following estrous synchronization and fixed time A.I. after the induction of an LH surge with GnRH or hCG. Theriogenology 58, 1675–1687.

Devendra, C., 1987. Goats. In: Jhonson, H.D. (Ed.), Bioclimatology and Adaptation of livestock. Elsevier Publ., pp. 157–167 No:15.

FAO, 2007. Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration. Rome. http://www.fao.org/ag/againfo/programmes/en/genetics/documents/Interlaken/GPA_en.pdf.

Görgülü, M., Koluman Darcan, N., Göncü Karakök, S., 2009. Goat production and global warming. 5. In: National Goat Nutrition Congress. 30 September- 3 October 2009, Çorlu, Turkey.

Güney, O., Gül, A., Darcan, N., Işık, H., Güney, I., 2006. The effects of global warming on the livestock production systems in the seyhan basin: case study of upper seyhan region. In: ICCAP Workshops in the RIHN Pre-Symposium 2006 Third Stage. Kyoto-JAPONYA.

Jhonson, K.A., Jhonson, D.E., 1995. Methane emmisions from cattle. J. Anim. Sci. 73, 2483–2492.

Koluman Darcan, N., Karakök, S.G., Daşkıran, I., 2009. Strategy of adapting turkish goat production to global warming, 1. In: National Symposium of Drought and Desertificiation. 14-16 May 2009 Konya-Turkey.

Koluman, N., Gültekin, U., Daşkıran, I., 2011. Future scenarios of goat husbandry and global warming for next 70 years. Final Report of Adaptation to Goat Production and Environmental Activities to Global Warming and Climate Change at Seyhan River Basin. UNDP (World Bank).

Macfarlane, W., Howard, B., 1972. Comparative water and energy economy of wild and domestic goats. Symp. Zool. Soc. Lond. 31, 261–296.

Macfarlane, W.V., 1968. Adaption of Ruminants to tropics and desert. In: Hafez, E.E.S. (Ed.), Adaptation of Domestic Goats. Lea & Febiger, Philadelphia, pp. 164–182.

Mc Dowell, R.E., Woodward, A., 1982. Concepts in Goat adaptation. Comperative suitablity of goats, sheep and cattle two tropical environments. In: Proceedings 3rd Int. Conf. On Goat Production and Disease. Jan 10–15th 1982, Tucson, 384–393, USA.

Moss, A.R., Jouany, J., Newbold, J., 2000. Methane production by ruminants: its contribution to global warming. Annales De Zootechnie 49, 231–253.

Puchala, R., Min, B.R., Goetsch, A.L., Sahlu, T., 2005. The effect of a condensed tannin-containing forage on methane emission by goats. J. Anim. Sci. 83 (1), 182–186.

Robertshaw, D., 1982. Concepts in goat adaptation, thermoregulation of the goat. In: Proceedings 3rd Int. Conf. On Goat Production and Disease. Jan 10–15th 1982, Tucson, 395–397.

Silanikove, N., Koluman, N., 2015. Impact of climate change on the dairy industry in temperate zones: predications on the overall negative impact and on the positive role of dairy goats in adaptation to earth warming. Small Rumin. Res. 123, 27–34.

Silanikove, N., 2000. The physiological basis of adaptation in goats to harsh environments. Small Rumin. Res. 35, 181–193.

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., de Haan, C., 2006. Livestock's Long Shadow: Environmental Issues and Options. Food and Agriculture Organization of the United Nationspp. 82–114.

TUIK, 2009. http://www.tuik.gov.tr http://www.tuik.gov.tr (Access date: 09 May 2016).